

# SIRTF Studies of Galaxy Evolution

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**Abstract.** SIRTF, the Space Infrared Telescope Facility, will complete NASA's family of Great Observatories, and is planning for launch in 2001. Two of the four scientific objectives being used to define SIRTF's capabilities concern galaxy evolution: the study of redshifted starlight from quiescent galaxies, enabling measurement of the field galaxy luminosity function to  $z > 3$ ; and the study of infrared luminous starburst galaxies, which SIRTF can observe to  $z \sim 10$  for the most luminous examples.

## 1. Space Infrared Astronomy and SIRTF

With the successful launch of the Infrared Space Observatory (ISO) on 17 November 1995, the glowing veil of Earth's atmosphere has again been briefly lifted. Like IRAS and COBE before it, ISO will view the cool and distant universe seen at infrared wavelengths, unfettered by atmospheric absorption or thermal radiation from the telescope itself, until it exhausts its supply of liquid helium. The next such opportunity will be provided by SIRTF, which will be the first space infrared observatory to benefit fully from the revolution in infrared detector technology which has occurred in recent years. The low-noise, large-format detector arrays now available will permit high angular resolution imaging over a wide field, with sensitivity limited only by thermal emission from zodiacal and galactic dust, emission a million times fainter than that from Earth's atmosphere. These arrays will also enable SIRTF to obtain long slit or echelle spectroscopy over large wavelength ranges in a single exposure. The table below summarizes SIRTF's planned observational capabilities.

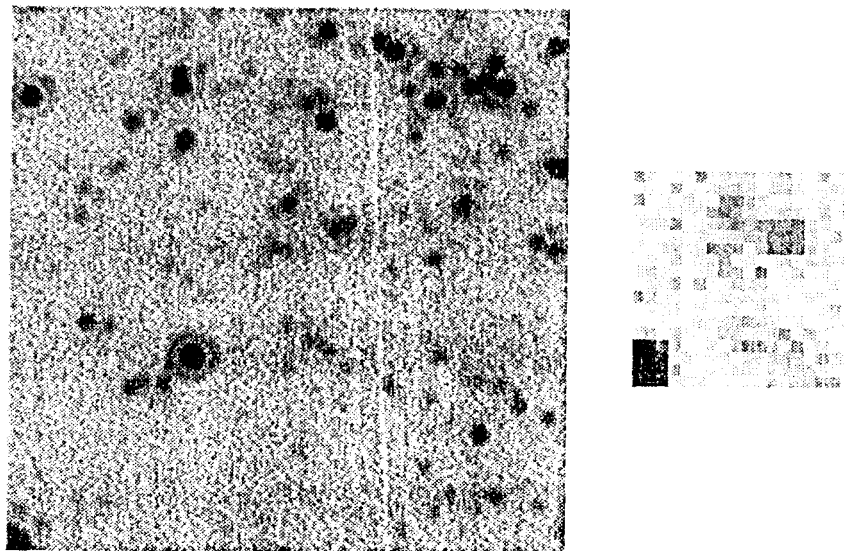
$\lambda(\mu\text{m})$	Array Type	$\lambda\Delta\lambda$	Field of View	Pixel Size (arcsec)	Sensitivity ( $\mu\text{Jy}$ ) (5 $\sigma$ in 500 sec)
<b>Infrared Array Camera: G. Fazio, SAO, P.I.</b>					
3.5	InSb	4	5' x 5'	1.2	1.5
4.5	InSb	4	5' x 5'	1.2	2
6.3	Si:As(IBC)	4	5' x 5'	1.2	20
8.0	Si:As(IBC)	4	5' x 5'	1.2	30
<b>Multiband Imaging Photometer for SIRTF: G. Rieke, U. Arizona, P.I.</b>					
12	Si:Sb(IBC)	4	0.5' x 5'	2.4	70
30	Si:Sb(IBC)	4	4.5' x 5'	2.4	150
70	Ge:Ga	4	2.7' x 2.7'	5/	530
			5' x 5'	9.4	
50-100	Ge:Ga	20	18.75' x 5'	9.4	3500
160	Ge:Ga (stressed)	4	0.5' x 5'	15	7500 (conf. ltd.)
<b>Infrared Spectrograph: J. Houck, Cornell, P.I.</b>					
3.75-15	Si:As(IBC)	50	3.6" x 18"	1.8	550 $\mu\text{Jy}$
10-20	Si:As(IBC)	600	4.8" x 12.1"	2.4	3 x 10 <sup>-18</sup> W/m <sup>2</sup>
15-40	Si:Sb(IBC)	50	9.7" x 72"	4.8	1.5 nW
20-40	Si:Sb(IBC)	600	9.7" x 24.2"	4.8	3 x 10 <sup>-18</sup> W/m <sup>2</sup>

## 2. Redshifted Starlight

The integrated starlight from distant galaxies is redshifted into the observed near infrared band. Most of the light is emitted by stars that have a peak emission at the  $1.6\mu\text{m}$  wavelength of the minimum of the  $H^-$  opacity. The  $1.6\mu\text{m}$  feature is present over a factor of 100 in age in Bruzual & Charlot galaxy models, a range including both actively and passively evolving stellar populations. SIRTf is being designed to sample over the  $1.6\mu\text{m}$  bump to  $z > 3$ , enabling the determination of photometric redshifts. Essentially, one measures the flux of an object at ever longer wavelengths until there is a drop in  $F_\nu$  corresponding to  $> 1.6\mu\text{m}$  in the rest frame. The photometric  $z$ 's will permit the measurement of such quantities as the field galaxy luminosity function vs. redshift to  $z > 3$ , an epoch when the space density of QSO's appears to be declining.

## 3. Infrared-Luminous Galaxies

IRAS discovered that far-infrared selected galaxies with luminosities above  $\sim 5 \times 10^{11} L_\odot$  have a space density comparable to or greater than quasars in the same luminosity range. Faint IRAS sources are far more numerous than brighter sources - there are five times more high latitude  $60\mu\text{m}$  sources in the Faint Source Survey than in the Point Source Catalog. Searches based on these catalogs led to the discovery of extremely distant "hyperluminous" IRAS galaxies, including FSC 10214+4724 at  $z = 2.3$ . SIRTf is being designed to map large areas ( $\sim 100$  square degrees) in the far infrared to flux levels one hundred times fainter than the IRAS Faint Source Survey. SIRTf will also have spectroscopic capabilities to determine the redshifts of these sources, and to determine accurate line ratios (e.g. Ne III  $15.6\mu\text{m}$  to Ne IV  $14.3\mu\text{m}$ ). These ratios will permit SIRTf to distinguish between different mechanisms for the fundamental energy source, and the ratios are nearly independent of extinction.



Simulated  $10' \times 10'$  mosaic of four 900 second SIRTf frames at  $60\mu\text{m}$ . The equivalent ISO picture is shown for comparison at right.